UNIVERSITI PUTRA MALAYSIA

DEVELOPMENT OF AN EXPERT SYSTEM FOR ISO 14001

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MUHAMMAD GHAZI

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DEDICATED TO:

MY BELOVED PARENTS,

(Ghazi Mahmod and Sri Rahayu)

AZMI

& MY FRIENDS.

(Anim, Malin, Ogy, Ayu, Yati and Sue)

THANK YOU VERY MUCH FOR YOUR SUPPORT.

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LIST OF ABBREVIATIONS

AI	Artificial Intelligence
CLIPS	C Language Integrated Production System
COOL	CLIPS Object Oriented Language
DYNACLIPS	Dynamic CLIPS Utilities
EM	Environmental Management
EMS	Environmental Management System
ES	Expert System
GUI	Graphical User Interface
NASA	National Aeronautics and Space Administration

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DEVELOPMENT OF AN EXPERT SYSEM FOR ISO 14001

By

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July 1999

Chairman : Dr. Ir. Mohamed Bin Daud

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The ISO 14001 standard is designed to assist organisations in implementing and maintaining Environmental Management System (EMS), verifying conformance with their environmental policies and objectives and demonstrating such conformance to other organisations via certification by a third party or via self-declaration. It is applicable to organisations of all sizes, types and locations and will be used to improve environmental performance by integrating designated EMS with existing management policies and procedures.

The main objectives of Expert System for ISO 14001 (ESISO) are to help the end-users in gaining information on ISO 14000 and EMS and to create EMS documentation as well as to help the application process of the company. CLIPS

version 6.04 was chosen for logic based knowledge representation in implementing ESISO.

The results show that the reliability of the Expert System (ES) was able to help the end-users to create EMS documentation and to obtain information on ISO 14000 as well as EMS. Information of ISO 14000 and EMS were validated using the information from various sources such as SIRIM, Singapore Productivity and Standards Board pamphlet, books and Internet. ESISO managed to show a 95% matching between the ESISO consultation and these sources. EMS documentation of a certified company was used to validate the EMS requirements that were incorporated in the ESISO. Therefore, for the case of that company ESISO consultation matched with this existing documentation.

The usefulness of the knowledge-based system depends on the degree to which the task it is reviewing is systematic. However, in environmental planning and engineering, it is difficult for planners and engineers to agree on the solution provided by ES, mainly because their subjective judgement can differ greatly from each other and the knowledge base used by the expertise tends to be extracted from various sources.

Abstrak tesis dikemukakan kepada Senat Universiti Putra Malaysia
bagi memenuhi keperluan Ijazah Master Sains

PEMBINAAN SISTEM PAKAR BAGI ISO 14001

Oleh

SRI IKAROSTIKA RAHAYU BINTI MUHAMMAD GHAZI

Julai 1999

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Piawaian ISO 14001 direkabentuk bagi membantu organisasi dalam melaksanakan dan mengekalkan Sistem Pengurusan Alam Sekitar (EMS), menentukan polisi alam sekitar dan sasaran serta mempamerkan penggunaan itu dengan organisasi-organisasi lain melalui pengesahan oleh saluran ketiga atau menerusi pengisytiharan persendirian. Ia boleh digunakan oleh semua organisasi tanpa mengira saiz, jenis dan lokasi serta akan digunakan untuk meningkatkan pengamalan alam sekitar dengan menyatakan Sistem Pengurusan Alam Sekitar yang telah ditetapkan dengan polisi-polisi pengurusan serta peraturan yang sedia ada.

Tujuan utama Sistem Pakar bagi ISO 14001 (ESISO) ini adalah untuk membantu pengguna-pengguna mendapatkan maklumat mengenai ISO 14000 dan Sistem Pengurusan Alam Sekitar dan juga boleh mewujudkan sistem dokumentasi

Sistem Pengurusan Alam Sekitar serta membantu proses pendaftaran syarikat-syarikat mereka. CLIPS Version 6.04 telah dipilih sebagai gambaran bagi asas ilmuan yang sahih dalam melaksanakan ESISO.

Penghasilannya membuktikan bahawa Sistem Pakar ini adalah untuk membantu pengguna-pengguna mewujudkan dokumentasi Sistem Pengurusan Alam Sekitar dan mendapatkan maklumat mengenai ISO 14000 dan juga Sistem Pengurusan Alam Sekitar. Maklumat mengenai ISO 14000 dan Sistem Pengurusan Alam Sekitar telah disahkan dengan menggunakan maklumat daripada pelbagai sumber seperti SIRIM, pamplet Singapore Productivity and Standards Board, buku-buku dan Internet. ESISO mampu menunjukkan 95% persamaan diantara pakar perunding ESISO dan sumber-sumber ini. Dokumentasi Sistem Pengurusan Alam Sekitar dari syarikat yang telah diiktiraf digunakan digunakan untuk mengesahkan syarat-syarat Sistem Pengurusan Alam Sekitar yang dimasukkan di dalam Sistem Pakar ini. Oleh yang demikian, berdasarkan syarikat ini,pakar perunding ESISO menunjukkan persamaan dengan dokumentasi ini.

Sistem asas ilmuan ini berfaedah tetapi tertakluk kepada kadar sistem kaji semula yang dilakukan. Walau bagaimana pun, perancangan alam sekitar dan kejuruteraan, adalah sukar bagi perancang dan jurutera-jurutera untuk bersetuju mengenai keputusan tertentu yang diberikan oleh Sistem Pakar, disebabkan pandangan yang sangat jauh berbeza dengan yang lain.

CHAPTER I

INTRODUCTION

Prologue

An expert system is a computer program with degrees of conformity to certain standard which stresses the painstaking care to deal with provable fact for the attainment of fidelity to accuracy.

Mental ability to observe and understand with keenness of intellect will enable to solve an intricate problem reaction. The power to recognise the hidden springs of behaviour will allow changes to take place to suit new circumstances or a different environment. This study focuses on environment with special emphasis in management on Environmental Management Systems (EMS) for an organisation.

Problem Statement

The ISO 14001 has been viewed by organisations in Malaysia as an important element in effort to achieve and demonstrate sound environmental performances.

This International Standard specifies the requirements to control the impact of their activities, products or services on environment, taking into account environmental policy and objectives.

Although, some organisations have carried out the exercise manually but an Expert System (ES) will be produced to become the most effective instrument towards achieving the environmental and economic goals.

The ES is a software containing among other things the domain-specific knowledge about the problem being solved including input information, user interface and explanation facility that can serve a dramatic purpose. By combining logic and employer expertise into software code, a practice or procedure that require days can be reduced to minutes or seconds.

Expert Systems continue to be part of building new sophisticated information systems. The new millennium will see more human methodology and thinking processes becoming computerised.

Objectives of the Study

The objectives of this research are :

a) To produce a suitable prototype Expert System in helping the end-user in gaining information's on ISO 14000.

b) To produce a suitable prototype Expert System in helping the end-user to create Environmental Management System documentation as well as getting their company registered.

c) To change a manual process of creating Environmental Management System documentation to a computerise process.

d) To create a user-friendly Expert System.

Scope of the Study

Scope of this study is to create a suitable prototype Expert System which can be use as a tool to view information's, guidelines and requirements in creating, developing, implementing and/or improving an Environmental Management System.

Possible Contribution and Output of the Research

Speed and accuracy will be significant with the contribution of an Expert System into the existing method. The reliability of the Expert System will enable the user to make better decisions. ESISO is aimed at organisations regardless of size, consultants, engineers, managers, educators and SIRIM for auditing an Environmental Management System.

CHAPTER II

LITERATURE REVIEW

Introduction

The ISO 14000 series, a project of the ISO, is a collection of voluntary consensus standards that have been developed to assist organisations to achieve environmental and economic gains through the implementation of effective Environmental Management Systems (Standards Council of Canada, 1999).

Successful management of any organisation today requires management adaptation to significant forces that compel the organisation to change. Implementation of an Environmental Management System (EMS) is a rapidly growing force affecting a tremendous number of businesses worldwide (Internet, 1997).

As more and more firms seek to come into conformance with the principals of the ISO 14000 standards, it has become increasingly critical to establish and document management systems for environmental matters (Internet, 1998).

Development of ISO

The introduction of the International Organisation for Standardisation (ISO) certification will become the authority and trademark for excellence and efficiency of the organisation activities, products and services. The responsibilities towards maintaining and improving the qualities of the respective fields will undoubtedly protect the natural phenomena affecting human lives (SIRIM, 1998).

The JUNE 1992 U.N. Conference on Environmental Department held in Brazil, ISO made a commitment to determine ways in which it might support the concept of "sustainable business development". Discussions were initiated by ISO with its members on appropriate roles for ISO toward this end through the formation of the Strategic Advisory Group on the Environmental (SAGE). Aware of the strong international desire to improve environmental performance in the business community, SAGE also saw the real potential that diverse national and regional environmental standards for Environmental Management Systems and tools. Therefore, SAGE recommended the formation of ISO Technical Committee 207 in 1993 to develop such standards, the ISO 14000 series, in the areas of Environmental Management Systems, Environmental Auditing, eco-labelling, environmental performance evaluation, life cycle assessment and environmental management terms and conditions (ANSI, 1999).

ISO 14000 is being developed by the International Organisation for Standardisation, based in Geneva, Switzerland. Founded in 1946, the organisation is composed of governmental and quasi-governmental member delegations representing over 100 countries. The American National Standards Institute (ANSI) represents the United States. Although originally focused on the development of product technical standards, the organisation shifted directions in 1979 and began work on a set of quality management standards that would later become known as ISO 9000. The ISO 9000 standards were designed to assure the quality of supplier products, free companies from duplicative quality assessments in different countries, assist companies in developing quality control systems, and provide certification for customers desiring error free products (Internet, 1996).

ISO 14000

ISO 14000 is a series of international standards for Environmental Management Systems (EMS) that has been developed since late 1980's. The voluntary standards are designed to help private and government organisations establish and objectively evaluate Environmental Management Systems or EMSs. It provides a standardised and internationally recognised blueprint for an effective EMS and how to establish such system. Besides that, it also focuses on organisation by providing a process-driven set of standards through which organisation can establish the kind of management framework necessary for good environment performance. The standards

also establish a process for third party evaluation and certification of EMSs (Colby & Nance, 1997).

Under ISO 14000, companies are required to define Environmental Policy, set of goals for implementing environmental management improvements, and create a culture of preparedness and commitment to Environmental Performance and conduct objective evaluations of progress or deficiencies in environmental management. The standards also establish a process for third – party auditing and certification of EMSs and guidance for product evaluation and labelling. All of the standards are short, simple documents and have been flexibly written to allow for implementation in facilities of different sizes and functions and in countries with varying regulatory structures and technological levels. As such, it is hope that ISO 14000 will provide a universal framework for improved Environmental Performance (Internet, 1997).

Similar to ISO 9000 (the International Quality Management Standard), the ISO 14000 system will be built around external attestation. A company will be able to have its Environmental Management System audited against the international standard by a third party, registrar to assess its appropriateness and effectiveness, Having passed the audit, the organisation will be registered to ISO 14001 (Ralf Wissman, Ernst & Young, 1998).

The 1990's have been an era of change in the world of Environmental Management. More governments, private organisations and political groups are calling

for heightened awareness, control and management of industry concerning effects upon air pollution, water pollution and hazardous material control. The European, Asian and American Communities are mandating environmental programs for industry. As competition becomes fierce, companies gaining ISO 14000 certification will have a clear edge in existing and emerging business markets with high profit potential (Brewer & Associates Inc., 1997).

A decade from now, we may recognise these standards as one of the most significant international initiatives for sustainable development. For companies, the key goals are to become more efficient – to get more output per unit input – while earning profits and maintaining the trust of their stakeholder (Arthur J. Hanson, 1997).

The standards apply to all types and sizes of organisations and are designed to encompass diverse geographical, cultural and social conditions. For ISO 14001, except for committing to continual improvement and compliance with applicable legislation and regulations, the standard does not establish absolute requirements for Environmental Performance. Many organisations, engaged in similar activities, may have widely different EMSs and performance and may all comply with ISO 14001 (Quality Network, 1996).

ISO 14000 Series

The ISO 14000 series addresses Environmental Management Systems, Environmental Auditing, Environmental Labelling, Environmental Performance Evaluation and Life Cycle Assessment. The international standards are voluntary standards for the establishment of a common world-wide approach to management systems that will lead to the protection of the earth's environment while spurring international trade and commerce. They will serve as tools to manage corporate environmental programs and provide an internationally recognised framework to measure, evaluate and audit these programs. When implemented, these standards will ensure consistency in environmental management practice, harmonise national environmental standards within an international framework, simplify registrations, labelling and conflicting requirements provide a single system for a transnational subsidiaries and offer guidelines for environmental management excellence. The ISO 14000 voluntary environmental management standards and guidelines are intended to be practical useful, usable for companies or organisations of all sizes, in both manufacturing and service industries (Internet, 1999).

ISO 14000 series consists of the following documents in various stages of preparation (Robert J.P. Gale, 1996). These include (Table 1) :

Table 1 : ISO 14000 Series

Standard	Title/Description
14000	Guide to Environmental Management Principles, Systems and Supporting Techniques
14001	Environmental Management Systems – Specification with Guidance for Use
14010	Guidelines for Environmental Auditing – General Principles of Environmental Auditing
14011	Guidelines for Environmental Auditing – Audit Procedures – Part 1 : Auditing of Environmental Management Systems
14012	Guidelines for Environmental Auditing – Qualification Criteria for Environmental Auditors
14013/15	Guidelines for Environmental Auditing – Audit Programmes, Reviews & Assessment
14020/23	Environmental Labelling
14024	Environmental Labelling – Practitioner Programs – Guiding Principles, Practices and Certification Procedures of Multiple Criteria Programs
14031/32	Guidelines on Environmental Performance Evaluation
14040/43	Life Cycle Assessment General Principles and Practices
14050	Glossary
14060	Guide for the Inclusion of Environmental Aspects in Product Standards

ISO 14001

The ISO 14001 standard is designed to assist organisations in implementing and maintaining an environmental management system, verifying conformance with their environmental policies and objectives and demonstrating such conformance to other organisations via certification by a third party or via self-declaration. While ISO 14001 specifies the essential elements of environmental management systems, it does not set required levels of environmental performance. The specific approach to determining conformance with the standard is up to the individual organisation based upon its own particular needs and circumstances. Although organisations may evaluate